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3. That from 1904 to 1913, inclusive, over 31,000,000 doses of vaccine virus were used in the United States, yet information was obtained of only 41 authenticated cases of tetanus occurring subsequent to vaccination. From this it is concluded that had the vaccine virus used during that time in the United States been at fault many more cases of tetanus should have followed vaccination.

4. That in view of the large number of vaccinations (about 585,000) done in the United States Army and Navy and the absence from them of a single case of tetanus following vaccination, the cases of tetanus following vaccination in the country at large were not due to infection contained in the virus.

5. That the average period from vaccination to onset of symptoms of tetanus in 83 cases of tetanus following vaccination was 20.7 days, while the average mortality of 93 cases was 75.2 per cent, this being slightly higher than the mortality of cases of tetanus due to other causes with an incubation period of 10 days or less.

Conclusions.

Cases of tetanus occurring 15 or 20 days subsequent to vaccination do not receive their infection through the vaccine virus, but in all probability the infection is received about the tenth day or later after vaccination.

The infection with tetanus is received by a contamination of the vaccination wound, such as may occur in the infection of any other surgical wound not properly cared for.

ANOPHELES AS A WINTER CARRIER OF PLASMODIUM.

THE MOSQUITO AS A PROPHYLACTIC INDICATOR.

By M. Bruin Mitzmain, Technical Assistant, United States Public Health Service.

This study was conducted during the period between February 3 and June 1, 1915. For the purpose a locality was selected proven to have had a malarial index of 40.9 per cent during September, 1914. At this time a total of 1,666 persons were examined.

A field laboratory was established at Scott, Miss., on the property of the Mississippi Delta Planting Co., a syndicate of planters controlling 15 contiguous plantations in Bolivar and Washington Counties. Acknowledgment is made of the intelligent cooperation of Drs. Miller and Lane, of Scott, and Mr. Salsbury and Prof. Fox, of the Mississippi Delta Planting Co., who lent every facility in their power for the pursuit of this investigation.

Material for the study was obtained in and about habitations and in the woods and swamps. House and stable inspections upon the various plantations were instituted in an effort to collect resting mosquitoes, but this soon proved not to be a fruitful source. Not until search was made under dwellings with the aid of an electric torch, were the desired mosquitoes located. The first Anopheline mosquitoes were found during the month of February, resting under the flooring of dwellings. They were collected daily and kept in glass bottles until evening, when the dissections were made. Tobacco smoke was found to anesthetize most satisfactorily. It was planned to collect only from known foci of infection, but so few mosquitoes were taken that it was found necessary to include all of the possible hiding places.

In the month of March relatively few mosquitoes were found under houses, and a more profitable collecting place was afforded in the woods, where natural shelters gave an opportunity for hibernation. At first an effort was made to collect the insects while at rest in the hibernating habitat, but it was soon found impracticable to obtain them in sufficient numbers. A horse was used to attract the mosquitoes, which method was employed during March and April, and discontinued when house infestation became general.

In considering the question of hibernation, it must be noted that in the region investigated true hibernation does not occur, for sporadic flights and occasional feeding prevail. This was demonstrated early in the study, between February 11 and 14, when an initial rise of 11 degrees of temperature was experienced, and a general house invasion of *Anopheles* resulted. Eight observers reported independently the attacks of the mosquitoes. Mr. Le Prince, who was then cooperating with me, reported that at 11 p. m. at Scott Hotel, he was bitten on three occasions by *Anopheles quadrimaculatus.* I saw four persons, including myself, bitten by the same species while hunting for mosquitoes in the woods. During this period (Feb. 11 to 14) 200 mosquitoes, fully one-half of the monthly catch, were captured upon horses in the woods of Mound Plantation, about 3 miles south of Scott.

The extent of the operations involved in collecting and dissecting is shown in the following table:

Anopheles dissected.

	Quadrimaculatus.	Crucians.	Punctipennis.	Total.
February	317	....	79	396
March	78	3	3	84
April	236	27	5	268
May	1,355	....	19	1,374
Total	1,986	30	106	2,122

After April 23, house and stable infestation were found to be common, although a general flight throughout the various plantation houses was not the rule even up to June 1.

The solution of the question of hibernation can not be assumed as the result of the present studies. It is desired merely to indicate that during three months, from February 9 to May 9, 1,000 *Anopheles* mosquitoes were dissected and examined and no forms suggestive of malarial plasmodium were encountered.

In considering the qualitative enumeration of the 1,000 mosquitoes it is important to determine first their origin. It is obvious, as regards infection, that unless we take into consideration the possibility of hereditary transmission, all of the mosquitoes must be of the brood wintering over from 1914, the question of fresh infection, of course, being held in abeyance. The opportunity for infection of mosquitoes is presented in the following:

1. Organisms carried over from the fall of 1914 in the body of the wintering mosquito.
2. The inactive mosquito of the winter months being stimulated during a warm spell and biting a human gamete carrier.
3. The newly emerged mosquito deriving its infection under the usual conditions favorable for parasitism.

No positive proof, however, is given that the mosquitoes dissected were of the fall brood. All the usual checks were tried to determine this point relative to the time of emergence, including constant surveillance of all the known breeding places to obtain young forms; inducing mosquitoes in the laboratory to lay their eggs and then following the course of development to observe the date of emergence, and rearing of larvæ and pupæ when first found in nature, in order to observe development and ultimate emergence. Also for this purpose note was taken of the condition of mosquitoes dissected as to probable age, quantity of fat cells, presence of spermatozoa in the spermatheca, and egg development. Account was also taken of the distribution of sex, especially in the appearance or absence of males. These tests, however fallible, were used in the absence of better criteria in considering whether the mosquitoes examined were new or wintering forms. As a result, it is assumed that wintering forms were the predominant ones encountered in this study until the latter part of April.

Setting aside the question of æstivation in the mosquito, if the *Plasmodium* does not hibernate in the mosquito carrier it is thought desirable to consider when in this locality the mosquito first appears infected in the spring. The significance thereof and its practical bearing are here considered. It seems quite feasible to establish for any endemic focus what may be termed the malarial indicator. This is the determination of the period of the year when mosquitoes first acquire malarial infection. Thus a fairly stable indicator may be obtained of the time when there is a danger of communicability of malaria from man to man. It might be entirely feasible to utilize the mosquito indicator to determine when active means of prophylaxis should be inaugurated in any locality, and if necessary likewise to determine at the end of the season when prophylaxis might be dispensed with safely.

To determine this indicator with any degree of accuracy, it is realized that a large number of possible insect carriers must be dissected within a very restricted area. With this purpose in view, mosquitoes were collected from a great number of negro cabins on plantations where the highest malarial index had been noted. Especial attention was given to cabins where active cases were known to occur, for it was thought that in the event of these being new infections the responsible carriers might still be harbored within the dwelling. Finally a more intensive plan was pursued: A group of eight cabins was selected in which gamete bearers had been discovered the previous fall. A second blood examination taken just prior to the mosquito dissections showed that at least six of these persons still harbored gametes; the remaining two only asexual forms. The latter were of the pernicious type, one of the gamete bearers proving to be a case of simple tertian and the remaining were subtertian cases demonstrating crescents.

The cabins of the six gamete bearers yielded daily large numbers of *Anopheles*, beginning May 9. Intimate host relations were obtained in many of the collections made from these sources. Though the bulk of the mosquitoes were found resting on the walls of living rooms, a moderate number were taken on or near the beds of *Plasmodium* carriers. In one instance 24 *Anopheles quadrimaculatus* were removed from under the bed net. They were all engorged and too helpless to find openings for escape. In one sleeping room of a certain cabin where six visits were made during the mosquito hunt, 450 Anopheles were found and many more remained which were resting near the middle of the ceiling. This room contained three beds accommodating four persons, one of whom was a crescent carrier. The investigation was continued with mosquitoes collected in the afternoon and dissected at night and on the following morning. Sometimes it was necessary to retain the insects for three to five days on account of the state of blood engorgement. The blood was digested in the interim, while the mosquitoes were kept in a large box cage provided with ample water and split prunes.

More than 1,100 *Anopheles*, from the six cabins referred to, were collected and examined during a period of 20 days. No malaria plasmodium like organisms were seen until May 15, when two mosquitoes, *A. quadrimaculatus*, were found infected. One with a fairly large nearly ripe oocyst but no sporozoits yet formed and another with the usual picture of the infected stomach with approximately 36 oocysts in various stages of development. Here were seen young oocysts with the typical peppered malarial pigment and half-grown forms with round and prickly appearing sporoblasts. No sporozoits were found here or in the dissected and stained salivary glands. The third infected *Anopheles* was found May 26. This contained six young to half-grown oocysts which stained in the characteristic manner. No sporozoits were encountered.

The practical bearing of these findings may be here indicated: From the therapeutic standpoint, at any time previous to May 15, in the locality investigated, protection from malaria may be secured by treating with quinine all the human carriers so that the insect carriers may not be permitted to carry out their rôle in completing the cycle. Failing this, prophylactic measures among healthy and other susceptible persons may be instituted any time from May 15 to June 1, when it is considered the completion of the mosquito cycle in this locality makes preventive measures urgent.

PLAGUE-PREVENTION WORK.

CALIFORNIA.

The following report of plague-prevention work in California for the week ended June 26, 1915, was received from Passed Asst. Surg. Hurley, of the United States Public Health Service, in temporary charge of the work:

San Francisco, Cal.

RAT PROOFING.

New buildings:	
Inspections of work under construction	154
Basements concreted (19,224 square feet)	36
Floors concreted (14,583 square feet)	31
Yards, passageways, etc. (11,827 square feet)	61
Total area of concrete laid (square feet)	45,634
Class A, B, and C (fireproof) buildings:	
Inspections made	212
Roof and basement ventilators, etc., screened	6,165
Wire screening used (square feet)	30,290
Openings around pipes, etc., closed with cement	10,279
Sidewalk lens lights replaced	800
Old buildings:	
Inspections made	701
Wooden floors removed	34
Yards and passageways, planking removed	16
Cubic feet new foundation walls installed	11,670
Concrete floors installed (39,960 square feet)	56
Basements concreted (8,911 square feet)	21
Yards and passageways, etc., concreted (46,511 square feet)	96
Total area concrete laid (square feet)	95,382
Floors rat proofed with wire cloth (2,400 square feet)	2
Buildings razed	27

RAT PROOFING—continued.

New garbage cans stamped "Approved"	750
Nuisances abated	358

OPERATIONS ON THE WATERFRONT.

Vessels inspected for rat guards	28
Reinspections made on vessels	35
New rat guards procured	6
Defective rat guards repaired	13
Rats trapped on wharves and waterfront	27
Rats trapped on vessels	17
Traps set on wharves and waterfront	159
Traps set on vessels	60
Vessels trapped on	10
Poisons placed on waterfront (pieces)	3,600
Poisons placed within Panama-Pacific International Exposition grounds (pieces)	7,200
Bait used on waterfront and vessels. Bacon (pounds)	6
Amount of bread used in poisoning waterfront (loaves)	12
Pounds of poison used on waterfront	6

RATS COLLECTED AND EXAMINED FOR PLAGUE.

Collected	291
Examined	228
Found infected	0

RATS IDENTIFIED.

Mus norvegicus	138
Mus rattus	52
Mus alexandrinus	55
Mus musculus	46